EFFECTS OF GRAZING ON THE MOVEMENTS
AND HABITAT USE OF WESTERN TOADS
(Bufo boreas) ON THE TARGHEE N.F.

Dr. Charles R. Peterson

FINAL REPORT FOR RESEARCH AGREEMENT
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"Effects of Grazing on the Movements and Habitat use of Western Toads (Bufo boreas) on the Targhee National Forest"
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PROGRESS REPORT

EFFECTS OF GRAZING ON THE MOVEMENTS AND HABITAT USE OF WESTERN TOADS (*Bufo boreas*) ON THE TARGHEE NATIONAL FOREST

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SUMMARY

We used radiotelemetry and physical models to study the effects of grazing on the movements and habitat use of western toads (*Bufo boreas*) on the Targhee National Forest. Biologists are interested in learning more about the biology of western toads because their populations appear to have declined in this portion of their range, and because they inhabit riparian habitats that are subjected to habitat change. Because riparian habitats and populations of species that utilize them may be changed by a number of activities, such as cattle grazing, the Forest Service has supported studies of how cattle grazing may effect these habitats.

We conducted the study in a riparian zone along Sheridan Creek on the Targhee National Forest. This area was part of a 91.7 km^2 grazing allotment that has been grazed annually since the early 1900's. We used a combination of radiotelemetry, physical models, automated data loggers, and a Global Positioning System (GPS) to gather data on the effect of late summer grazing on the movements and habitat use of western toads. Limited time and resources prevented us from repeating this study at another ungrazed site to control for changes in seasonal conditions. We telemetered eight toads during the grazing period, most of which we had followed since June so we could compare pre- and post-grazing movements. To determine habitat use, we recorded the habitat and environmental conditions of each terrestrial microsite used by a toad and at a randomly selected, paired site. At each site we measured air temperature and relative humidity, and the percent ground cover, shrub cover, and canopy cover. To determine how grazing may have affected the environmental conditions of habitats used by toads, we used three pairs of wet physical models, distributed among grazed habitats and similar habitats protected from grazing by exclosures. To determine the extent of grazing, we systematically sampled 100 sites in each of three habitat areas. We have completed some descriptive statistics for this report. For the final report, we will use a Geographical Information System (GIS) and several statistical analyses to determine which results are significant.

We observed very little direct or indirect effects of grazing on toads. However, any conclusions from this study are limited by the lack of controls. Changes in weather conditions, more than activity of cattle, seemed to affect the movements and habitat use of these western toads. Presumably, because the summer of 1994 was hot and dry, toads moved to sites within 5 m of permanent water by early August (before grazing began), and remained in or near water for the rest of the season. They moved primarily during brief periods of rain. In contrast, on only two occasions did we observe direct cattle-toad interactions.

Under the conditions of this study, cattle seemed to graze selectively. In all habitats, herbaceous cover (*e.g.,* grasses and sedges) and non-willow shrubs (*e.g.,* alder and dogwood) were grazed most heavily, especially under the canopy along Sheridan Creek. The evaporative water loss of models in grazed habitat under the canopy was higher than in the habitat protected by the exclosure, and the temperature in the grazed habitat was more variable with higher maximums and lower minimums.

INTRODUCTION

This progress report describes the preliminary results of fieldwork we conducted during 1994 to determine the effect of late season cattle grazing on the movements and habitat use of western toads (*Bufo boreas*) on the Targhee National Forest (TNF). It is in partial fulfillment of contract #INT-94958-RJVA between Idaho State University and the Intermountain Research Station of the U.S.D.A. Forest Service. We will describe: (1) the study site, (2) our methodology, (3) effects of grazing on toad habitats, (4) direct and indirect effects of grazing on toad movements and habitat use, and (5) our plan for completion of data analyses. A final report will be completed by November 1995.

Objectives

The general goal of our research is to determine the habitat relationships of western toads in the Greater Yellowstone Ecosystem (GYE). This research will form a basis for developing predictive habitat models for this species which, when used with a Geographic Information System (GIS), will improve our ability to map toad distribution in the GYE. The specific objective of this study is to gather and analyze data on the effects of grazing on the movements and habitat use by western toads on the Targhee National Forest (TNF). It is part of a larger study to examine the habitat relationships of western toads. A major aspect of our research is focused on how habitat changes, resulting from land use activities, may affect western toads. Land uses may affect toads directly (*e.g.,* individual animals), or indirectly (*e.g.,* by making habitat less suitable). For example, cattle also may affect toads directly, by trampling or crowding toads out of a pond, or indirectly by altering habitat so that it is no longer suitable for toads (*e.g.,* fouling a pond with sediment or excrement, or making a terrestrial site too hot and dry for toads)(Figure 1). Specific questions of this study are: (1) How do the presence and activity of cattle affect the movements of adult western toads? (2) How are the microenvironmental conditions of habitats affected by grazing? (3) How do changes in habitat caused by cattle affect habitat use by toads?

Significance

This research is important for two main reasons. By providing more information on how toads use habitats, it will help biologists to: (1) understand better why certain amphibian populations are declining, and (2) manage more effectively for sensitive species of amphibians that utilize riparian habitats.

Numerous populations of true frogs and toads (families Ranidae and Bufonidae, respectively) appear to be declining, and this seems to be a worldwide phenomenon (Corn and Fogelman 1984, McAllister and Leonard 1990, Wake and Morowitz 1990, Wyman 1990, Wake 1991). Populations of western toads have experienced declines in the southeastern portion of their range, including the GYE (Peterson *et al.* 1992). In the eastern part of its range (Colorado and Wyoming), this species has recently been listed as a C2 species (threatened or endangered), and in Idaho, the Bureau of Land Management and the State of Idaho have listed it as a sensitive species (Conservation Data Center 1994).

Although amphibian populations can experience natural wide fluctuations (Pechmann *et al.* 1991, Wissinger and Whiteman 1992), the global scale at which these declines seem to be occurring has led many in the herpetological community to suspect that some anthropogenic cause(s) may be contributing to these declines (Hayes and Jennings 1986, Weygoldt 1989, Bissonette and Larson 1991, Carey 1993). The potentially harmful effects of some human activities (*e.g.,* logging; increased incidence of ultraviolet light) have been shown (*e.g.,* Corn and Bury 1989; Blaustein 1994, respectively), while the effects of others (*e.g.,* weakening of the immune system) are currently being tested (Carey 1993).

Although there is considerable anecdotal accounts of the effects of grazing by cattle on amphibians, there is a lack of controlled experiments in this area. The effects of cattle grazing is a concern to biologists and resource managers, in part because cattle spend a disproportionate amount of time in riparian areas as compared to xeric upland areas (Clary and Webster 1989). Excessive grazing and trampling of an area by cattle can reduce or eliminate riparian vegetation (Clary and Webster 1989). On the TNF, where toads selected habitats (including riparian) with relatively greater amounts of shrub cover (Bartelt and Peterson 1994), cattle may affect the movements and habitat use of toads. A general, limited survey of amphibians on the TNF by Clark *et al.* (1993) found no evidence for effects of grazing on amphibians. However, a survey by Munger *et. al.* (1994) in southwestern Idaho indicated that a higher percentage of sampling sites where little or no grazing occurred contained spotted frogs (*Rana pretiosa*) than sites that received substantial grazing. To our knowledge, no controlled studies have been conducted to examine whether grazing affects amphibians.

METHODS

To determine the effects of grazing on the movements and habitat use of western toads,

we measured the effect of grazing on the structure and environmental conditions of habitats used by toads, and on the movements of western toads before and during cattle grazing. A weakness in this study was the absence of controls to separate the effects of season and grazing on toads. Limited time and resources prevented us from duplicating our study simultaneously at a similar, ungrazed site.

Study Sites

The study site was in a riparian area along Sheridan Creek, near the western edge of the Island Park District on the Targhee National Forest (TNF)(Figure 2). Clark *et al.* (1993) found toads along this creek in August 1992, and Bartelt and Peterson (1994) telemetered four toads along this creek beginning in September 1993. The site for this study is approximately 1.5 km southeast of the area described by these prior studies.

Sheridan Creek is a permanent stream that begins in the Centennial Mountains and carries water to Sheridan Reservoir, located between Kilgore and Island Park, Idaho. The lower reach of this stream was lined with Engelmann spruce (*Picea engelmannii*) and Douglas-fir (*Pseudotsuga menziesii*), and a shrub understory dominated by willow (*Salix* spp.) and red-osier dogwood (*Cornus stolonifera*). An expanse of shrub (primarily willow), interspersed with patches of herbaceous meadow and beaver ponds, bordered the riparian canopy on the west. The study site was centered along the edge of the riparian canopy and shrub expanse (Figure 3).

This area is part of the 91.7 km^2 *High Five C&H* grazing allotment that has been grazed by sheep and cattle annually since the early 1900's (Kevin Greenwood, Range Conservationist, TNF, *pers. comm.*). Beginning in the late 1960's or early 1970's, the area has been grazed by cattle only. It currently is grazed under one of two grazing schedules: early (July 15 - August 20) or late (August 20 - September 30). The time of grazing is rotated between these early and late periods, so that the area is grazed early for two years, then late for two years, and so on. In 1994, the area was grazed late, and about 500 cattle grazed the lower half of the allotment that contained our study site. The cooperating rancher (Jim Hagenbarth, Dillon, MT) hired a cowboy that checked the cattle daily to monitor their health and to be sure the cattle stayed within the designated area.

Study Animals

Western toads are the only true toads that occur in the GYE (Stebbins 1985). They are brownish or greenish in color, and have a distinctive tan stripe down their dorsum. Although western toads are still widely distributed throughout the GYE, their numbers appear to have

diminished (Peterson *et al.* 1992). Reports by Jim Hagenbarth (rancher, Dillon, MT, *pers. comm.*) a long-time resident of the area, indicate the numbers of western toads along Sheridan Creek have greatly diminished since 40 years ago.

Habitat/Environmental Conditions

We began the study with this general hypothesis: If habitat changes caused by grazing makes habitats less suitable for toads, then we should observe toads selecting ungrazed habitats. To determine habitat use and selection, we compared the habitats they used to those that were available, and recorded each as grazed or ungrazed. Because the habitats selected by these ectothermic animals can have significant consequences on their physiology and survival (Huey 1991), we also measured the environmental conditions (e.g., temperature, relative humidity) of used and available habitats.

Habitat. Wet-skinned ectotherms, like western toads, are closely coupled to their thermal and hydric environments (Spotila *et. al.* 1992). The environment experienced by a western toad is directly influenced by the structure of habitat. Because grazing alters the vegetative structure of habitat, we compared the vegetative structure and microsite conditions of used and available habitats as an indicator of indirect grazing effects.

To determine which habitats in the general study area were selected by western toads, and if grazing affected habitat, we measured the vegetative structure and composition of each site used by a toad and at a randomly selected site. We sampled habitats at two scales: in a 0.25 m^2 area (0.5*x*0.5 quadrat) and in a 1 m^2 (1*x*1 m quadrat) area (Figure 4). We used the two different scales to determine which habitat components were most important within the immediate microsite used by a toad. We compared the data collected at the sites used by toads to those of random sites to determine which habitats were important within the general area. If they were different, we considered this to be an indication of habitat selection.

Each time we located a telemetered toad we measured the percent of ground, shrub, and canopy cover at both scales. We used these quadrats to measure amounts of shrub cover and five categories of ground cover (herbaceous, litter, debris, bare soil, and water). Each quadrat was divided into 25 cm^2 squares, and percent cover was determined with the point-interception method. Because ground, shrub, and canopy cover each were measured independently, the total cover for any site could exceed 100 percent. We measured the height of herbaceous cover, because this is an important criterion for measuring the extent of late-season grazing (Clary and

Webster 1989). Canopy cover was measured with a spherical densiometer. Finally, we measured the distance to the closest cover from the animal's location (Dueser and Shugart 1978).

Cattle may alter habitats by grazing, trampling, defecating, or by creating potentially entrapping hoof prints (David Martin, *pers. comm.*). To relate any changes in habitat structure and habitat use by toads to the number of cattle grazing the area, we estimated the number of cattle using the study area each time we relocated toads. To determine how extensively cattle altered habitats in the study area, we collected 100 habitat samples in each of three general habitats: riparian canopy, shrub/herbaceous, and meadow. Samples were taken in a systematic fashion at 10 m intervals along transects. For all samples, we measured percent herbaceous cover with a 0.5*x*0.5 m quadrat, height of herbaceous cover, and we visually estimated the percent of new shrub growth cropped by cattle. Each sample was classified as "grazed" or "ungrazed."

Environmental Conditions. To measure the influence of habitat structure on the environmental conditions of sites used by toads, we measured the temperature and relative humidity of each microsite used by toads. We measured temperature and relative humidity with a psychrometer probe (Check-It Electronics, Inc., Elizabeth, NJ), that was equipped with a dry and a wet thermocouple. We repeated these measurements at each random site for a comparison. We recorded 0.7 m air temperature and relative humidity with a CR10 data logger, so we could relate general weather conditions to the movements and habitat use of toads.

An effective way of measuring the thermal conditions experienced by an animal is to measure operative environmental temperature (T_e)(Bakken 1992). For many animals, T_e can most easily and accurately be measured with physical models (Bakken 1992, Peterson *et al.* 1993). We used models made of hollow copper tubes (C.R. Peterson and M.E. Dorcas, unpubl. data) that were about 70 mm long and about 35 mm wide. To mimic the wet skin of toads, each model was covered with a sleeve of brown cotton fabric that wicked water from a 500 ml Nalgene bottle, buried under the model. This kept the model wet.

We tested these models to determine how closely they mimic the thermal and hydric properties of western toads. The solar radiation absorptivity of this wet fabric was tested in the laboratory of Dr. Warren Porter, and was found to be similar to the absorptivity of western toads studied by Carey (1978) in Colorado (Richard Dwelle, Univ. of Wisconsin, *pers. comm.*). In addition, simultaneous tests of these models and live toads showed that the models recorded

temperatures within 1° C of live toads, and predicted rates of evaporative water loss (EWL) reasonably well (these analyses will be discussed in the Final Report).

Temperatures of each model were recorded by a StowAway one-channel data logger (Onsett Computer Corp., Pocasett, MA), and EWL was determined by measuring the change in volume of water in the buried Nalgene bottle with a 10 ml plastic pipette and caliper. To do this, we inserted the plastic pipette through a hole in the lid of the bottle until it rested on the bottom of the bottle. After waiting about 15 seconds for water to rise to its level in the pipette, the top of the pipette was sealed and the pipette removed from the bottle. A caliper was used to measure the height of the water column in this pipette to the nearest 0.01 mm. Five separate readings of each bottle were averaged to determine actual water column height. We used a regression formula ($R^2 = 0.99$) to convert the water column height to volume. To track daily EWL, we repeated this procedure daily, between 10:00 and 11:00.

We tested the applicability of these models by using six models to measure how grazing might affect toad T_e and EWL. We placed three models in areas grazed by cattle and three in ungrazed areas. Because limited resources prevented us from measuring daily EWL throughout the grazing season, we measured daily EWL at four different time periods, for 3-4 consecutive days.

Movements

To follow the movements of individual toads, we used a combination of radio telemetry, and a Global Positioning System (GPS). We telemetered eight toads for various lengths of time from late May until early October (Figure 5). We secured a 1.85 g transmitter (model BD-2GT, Holohil Systems, Ltd., Woodlawn, Ontario, Canada) to each of eight animals with a small plastic belt harness (Bartelt and Peterson 1994). Each animal was located every 2-3 days.

The movement patterns of each toad were mapped with a combination of a GPS and GIS. The locations of each animal were flagged, and the Universal Transverse Mercator (UTM) coordinates for each were recorded with a *Trimble Basic*$^+$ GPS at a later time. To improve the accuracy of these UTM coordinates, the positions recorded by the GPS were differentially corrected in the laboratory with base files created by GPS base stations located either at Pocatello, Shoshone, or Idaho Falls, Idaho. The corrected positions were imported into PC ARC/INFO, a GIS (ESRI, Redlands, CA), to produce a map of toad movements.

Data Analysis

This report includes only some preliminary and descriptive analyses. For the Final Report, we will use several statistical techniques to test for significant trends or differences among the movement and habitat use data. We will compute rates of toad movements and use a GIS to map these movements. We will use a *t*-test to test for differences in the frequency and rates of movement, and circular statistics (Batschelet 1981, Zar 1984) to test for orientation of movements. We will use repeated measures MANOVA to compare habitats used by toads before and during the grazing period, and to compare habitats used by toads to habitats of random sites. The T_e recorded by models in grazed and ungrazed habitats will be compared with trend analysis, *t*-test, or other appropriate statistics. The lack of controls will make any conclusions tentative.

PRELIMINARY RESULTS & DISCUSSION

Radiotelemetry

We began the season with only three telemetered toads, because five of the eight transmitters we ordered did not arrive until later in June. Except for a few problems, the telemetry seemed to work very well this year. All toads wore their transmitter for the majority of the season and all gained and maintained weight. One toad (#10) gained over 25 g in one month. Only two toads developed skin sores near the end of the season, after which we removed the transmitters.

Effect of Cattle Grazing on Toads

Compared to the total number of cattle released into the allotment, relatively few grazed in the study site. Cattle were most numerous in the study area early in the grazing period; we counted a maximum of 38 cattle in the general area on August 31. In general, the presence of cattle seemed to have little effect on toads.

Effect on Habitat Conditions. In all three habitat areas (canopy, shrub, meadow), cattle grazed herbaceous and non-willow shrub cover the most heavily (Figure 6). Herbaceous cover was reduced (Figure 7*a*) and was much shorter in grazed areas, especially in the canopy (Figure 7*b*). Cattle cropped dogwood much more heavily than willow (Figure 8). The effect of grazing on microenvironmental conditions under the canopy was apparent from data recorded by the physical models. By the end of the grazing period, the model in the grazed area had warmer

maximum temperatures and colder minimum temperatures than the ungrazed area (Figure 9), and an overall greater rate of EWL (Figure 10). The biological significance of these differences to toads is unknown and needs to be tested. These results may mean that grazed sites could be less suitable to a wet-skinned ectotherm such as a toad. However, because toads had generally moved to aquatic sites before grazing began and used these microsites over 90 percent of the time during the grazing period, we suspect the grazing of this habitat probably did not affect these toads.

Effect on Toad Movements and Habitat Use. We did not observe any trampled toads, and on only two occasions did we observe cattle-toad interactions that may have disturbed toads. On one occasion a cow and calf grazing at the edge of a small (<10 m^2) pond may have caused toad #21 to move out of the pond to a willow bush about six meters to the north. It returned to the pond after the cow and calf left. On another occasion, toad #11 vacated an often frequented stream bank after cattle heavily grazed the sedge (*Carex*) growing there. While these observations may suggest that cattle directly affected toads to some degree, we do not feel it is strong evidence.

Toads at Sheridan Creek traveled short daily distances (usually ≤10 m), their movements did not seem to follow straight-line directions, and none left the Sheridan Creek riparian area. Observations made by ourselves and Stephen Sullivan (student intern, Carroll College; *pers. comm.*) showed that, until late July, the toads generally inhabited terrestrial microsites within 100 m of water during the day, and at night traveled to nearby water (Sheridan Creek or a nearby beaver pond) to rehydrate. This pattern changed in early August, before grazing season, when toads consistently used microsites in or near (≤5 m) water, and remained hidden all day under stream banks or debris dams (Figure 11). Because this change of habitat use occurred before grazing began, we attribute this change of movement pattern to the unusually warm and dry conditions of the 1994 season, rather than the activity of cattle.

IMPLICATIONS FOR FUTURE RESEARCH & MANAGEMENT

These data are preliminary and studies with controls are needed (*i.e.*, studies that include replication at another similar, but ungrazed, study site). In this way, a direct comparison could be made between changes in movements and habitat use that were caused by changes in season

to that of changes in habitat caused by cattle. This study also should be repeated earlier in the season to test if early or mid-season grazing affects toads inhabiting terrestrial habitats.

These data suggest that late season grazing may have very little effect on the movements and habitat use by toads, especially during dry years. Data from this study also suggest that using wet physical models is an effective way to measure changes in microenvironmental conditions caused by grazing, or other land use practices. The temperatures and rates of EWL measured with these models may be useful for predicting the suitability of altered habitats for other organisms (*e.g.*, salamanders, tree seedlings, small mammals).

ACKNOWLEDGEMENTS

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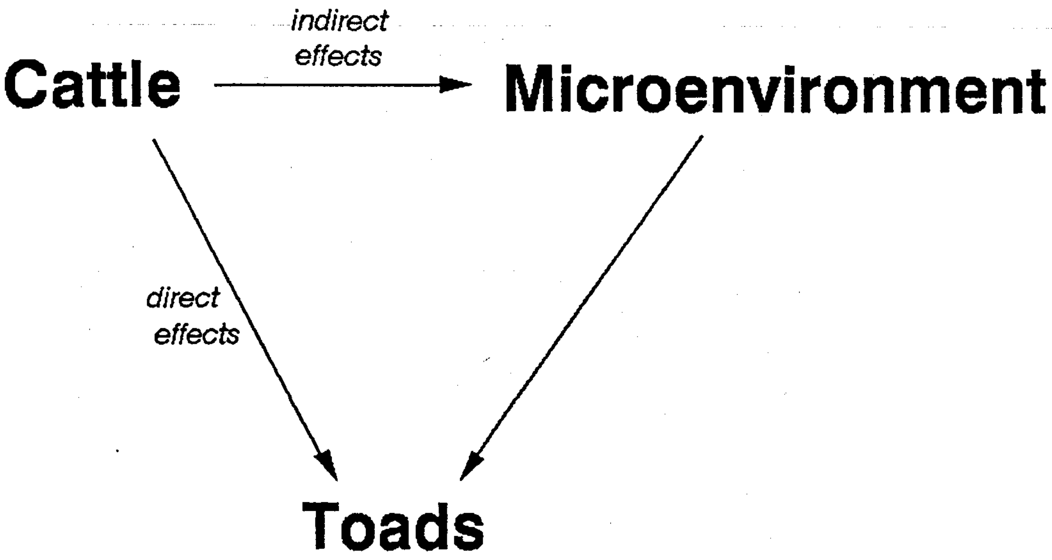


Figure 1. Effects of cattle grazing on toads. Cattle may affect toads *directly* (*e.g.*, trampling), or *indirectly* (*e.g.*, making habitats less suitable).

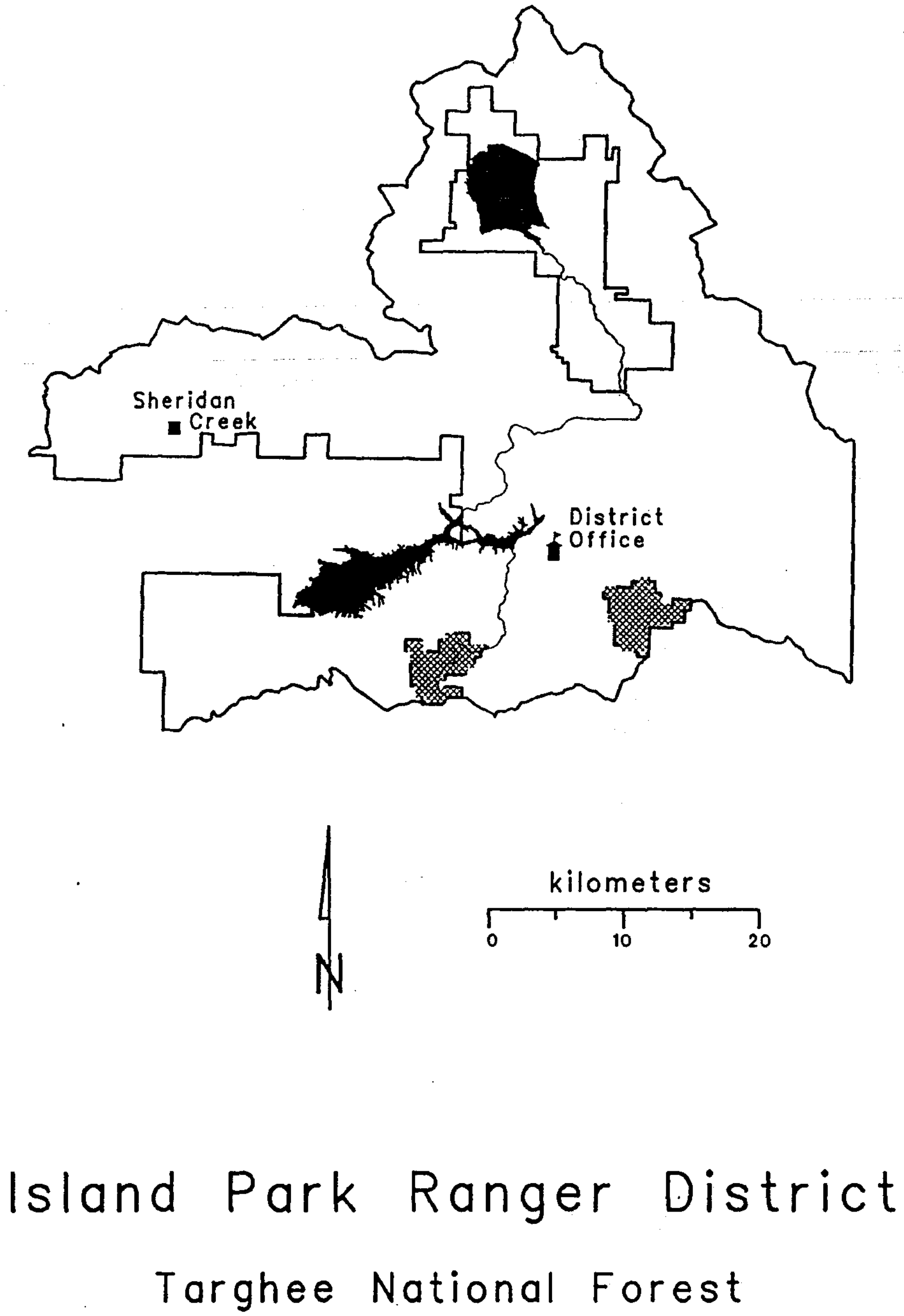


Figure 2. Location of the Study Site on the Targhee National Forest.

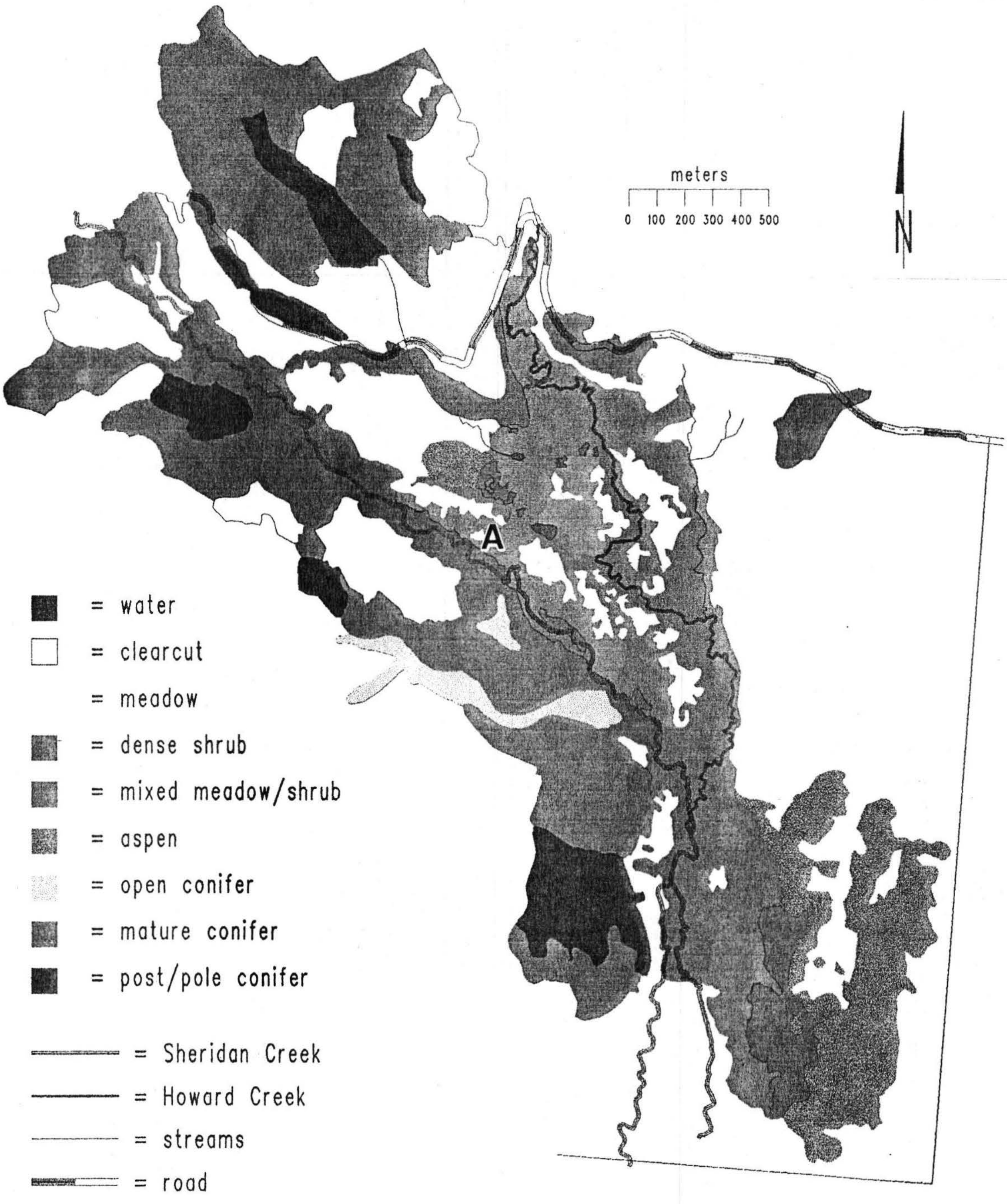


Figure 3. Cover map of the study area, drawn with PC ARC/INFO, a Geographic Information System. The label "A" designates the primary study area. For the Final Report this map will be used to illustrate toad movements.

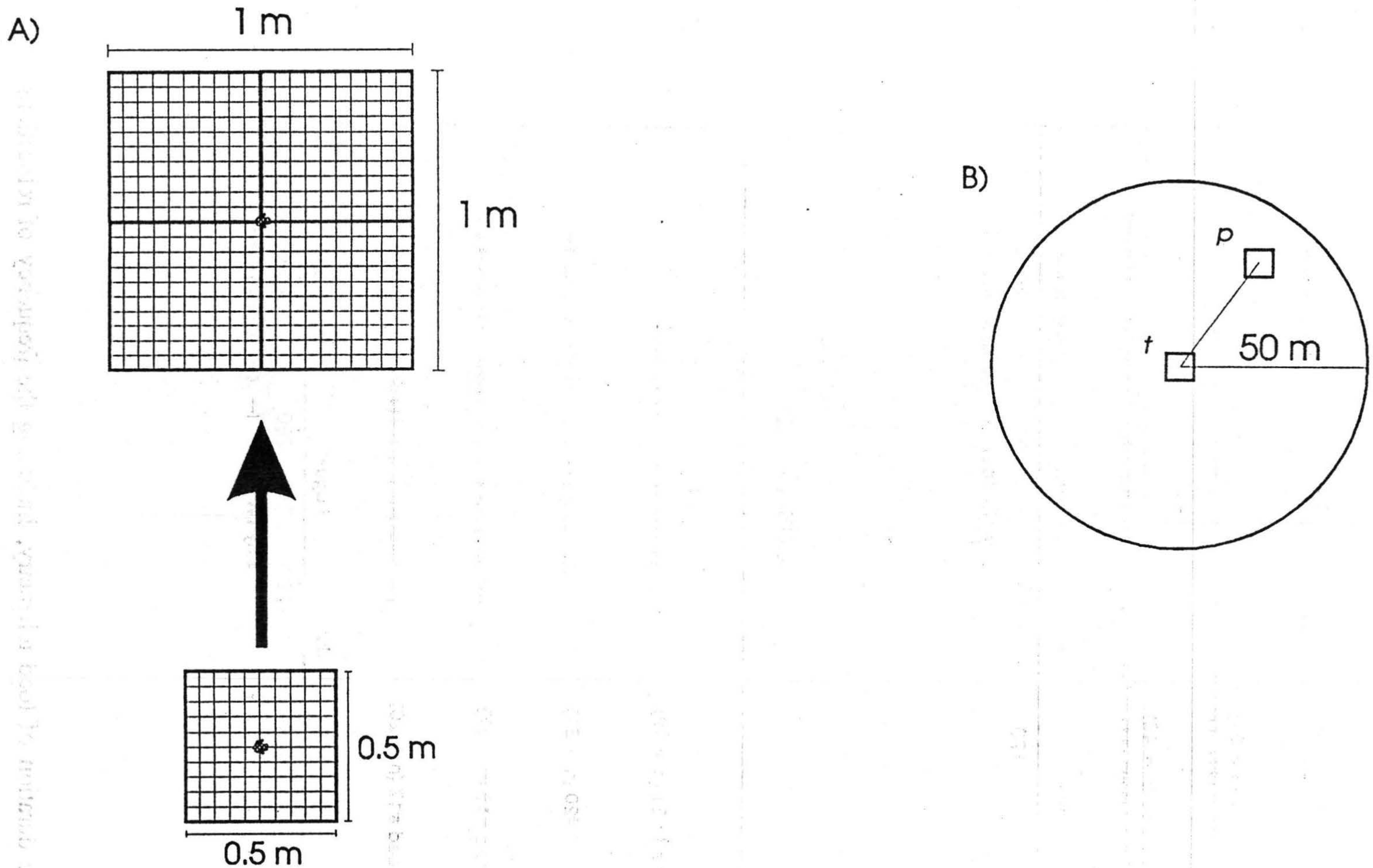
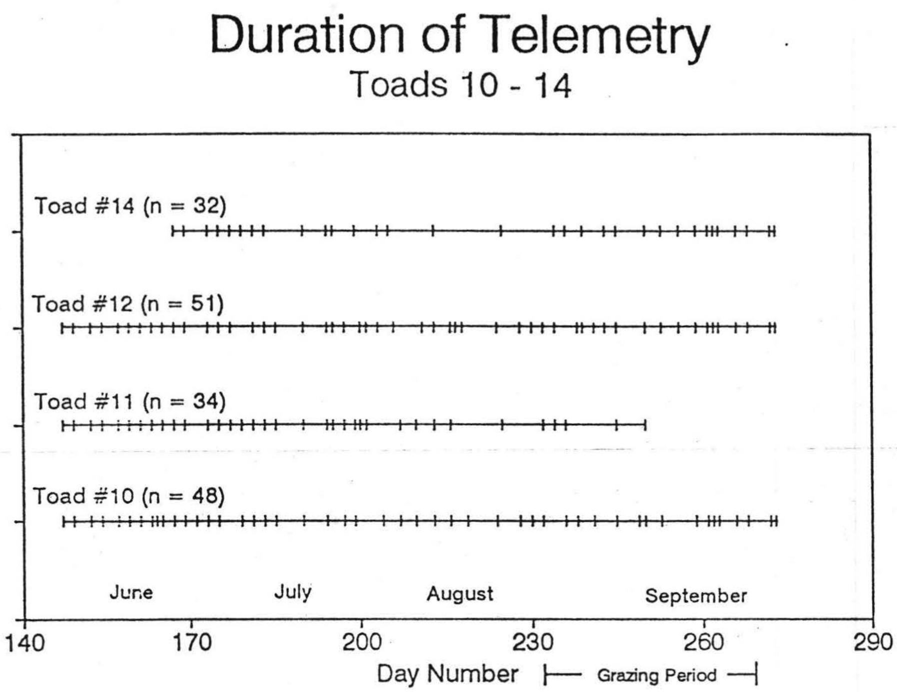


Figure 4. Our method of sampling habitat. *A)* We used the point-interception method to sample ground and shrub cover within a 0.5*x*0.5 m^2 and 1*x*1 m^2 quadrat at each toad site and at a randomly selected paired site. Both scales of quadrats were centered at each site. *B)* Each paired site (*p*) was at a random polar coordinate within 50 m of the toad's location (*t*).



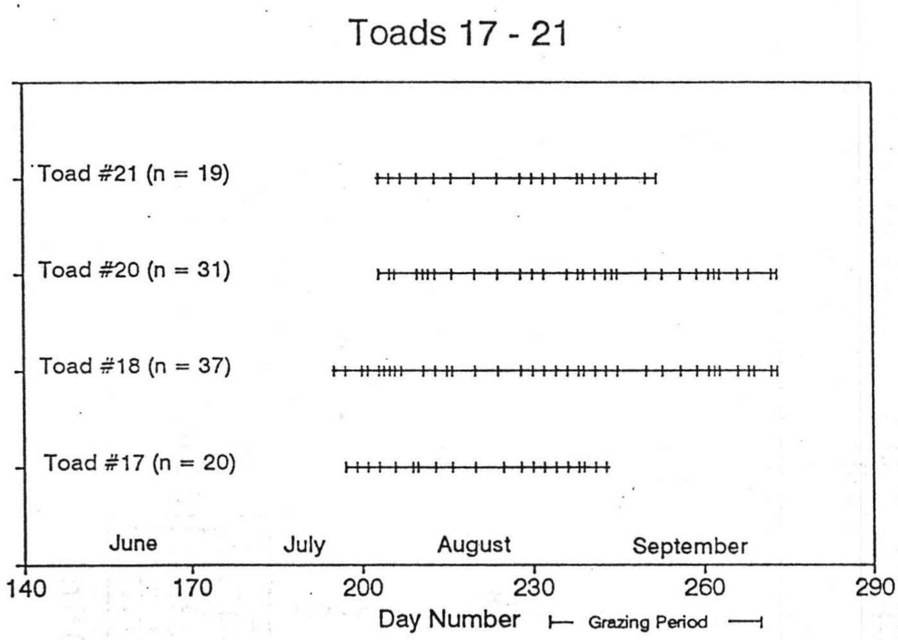


Figure 5. The duration of toad telemetry, including the frequency of relocations.

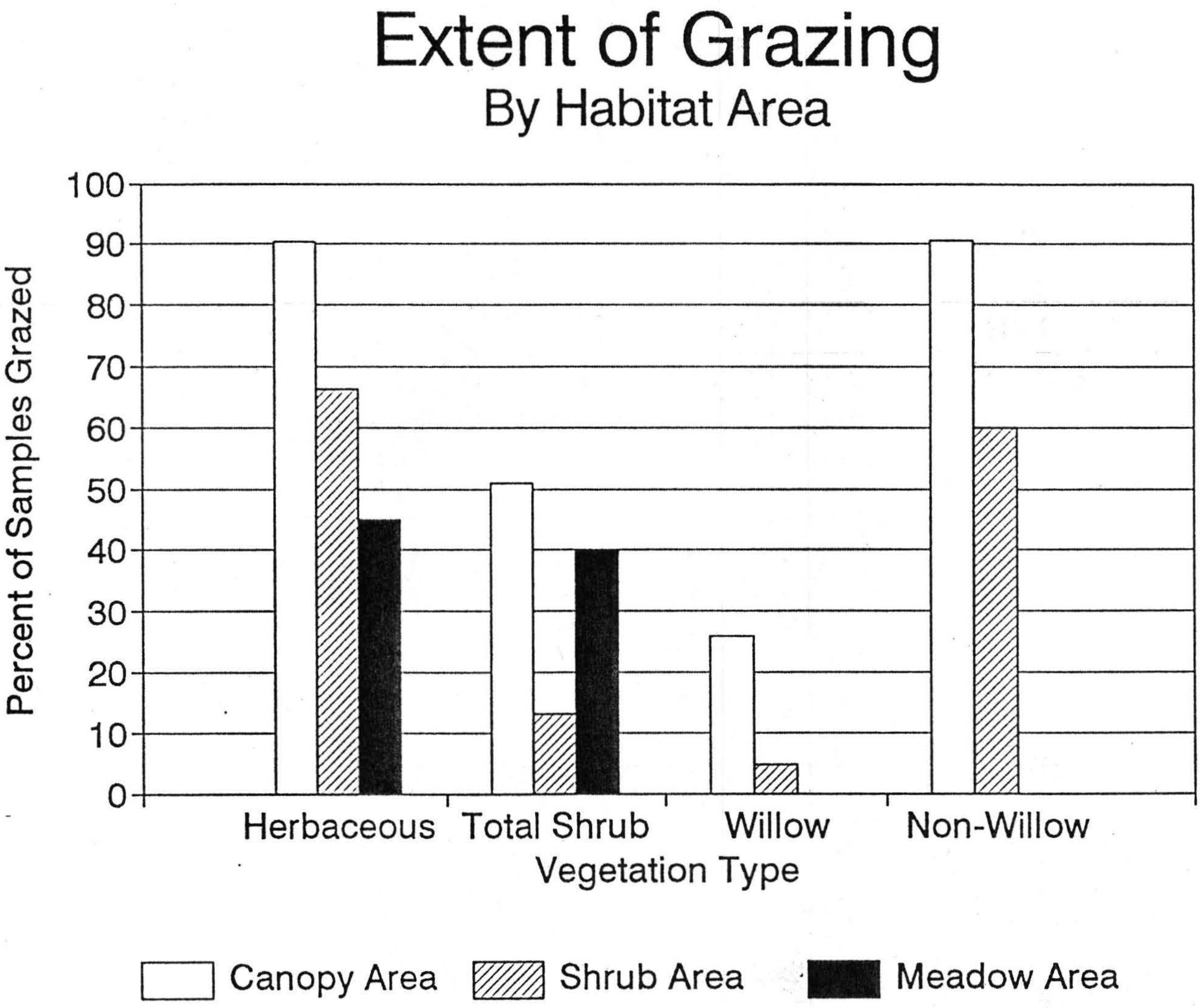


Figure 6. Extent of grazing on vegetation. Cattle grazed herbaceous and non-willow vegetation the most heavily in all three habitat areas.

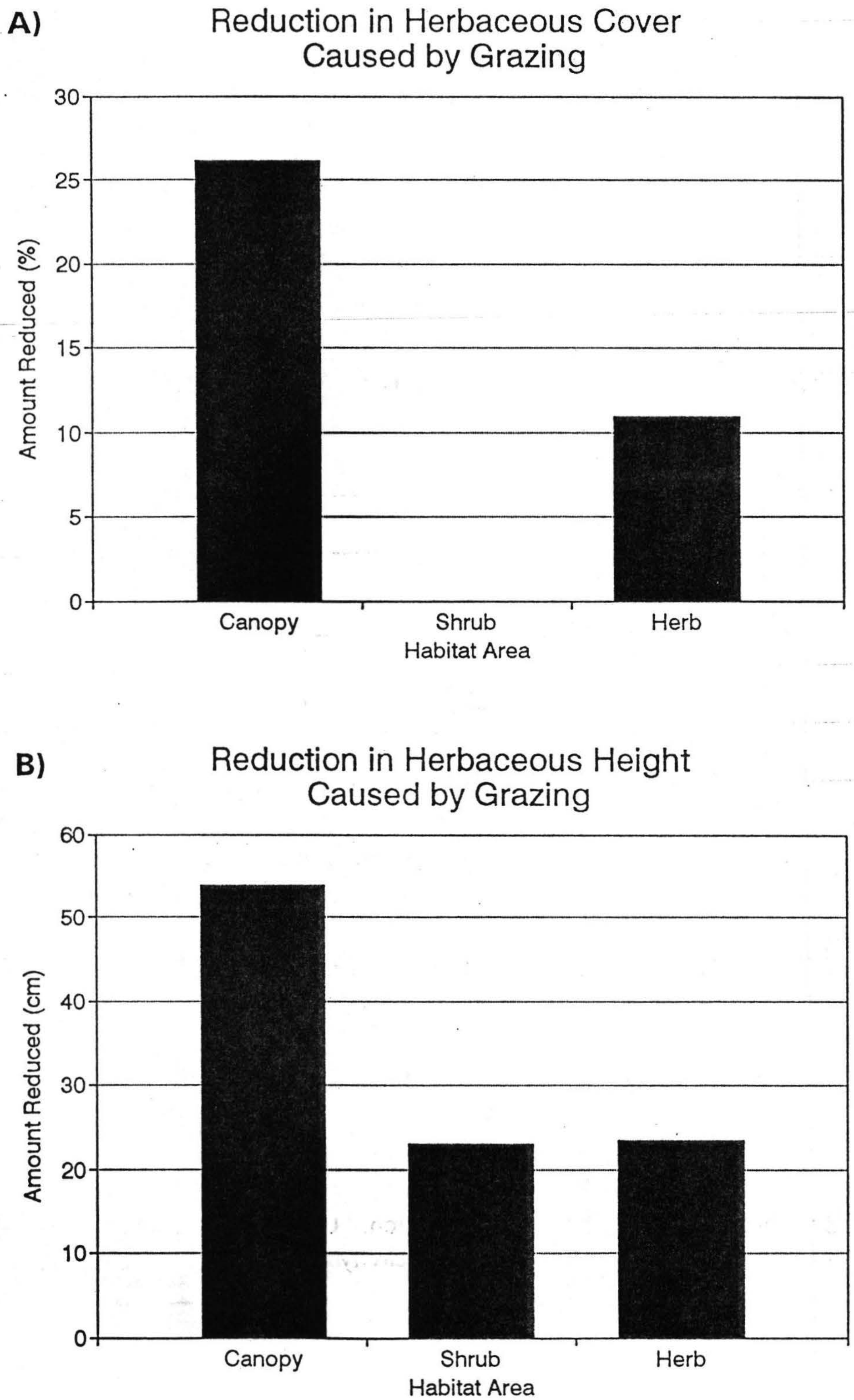


Figure 7. Effect of grazing on herbaceous cover(*A*) and height (*B*).

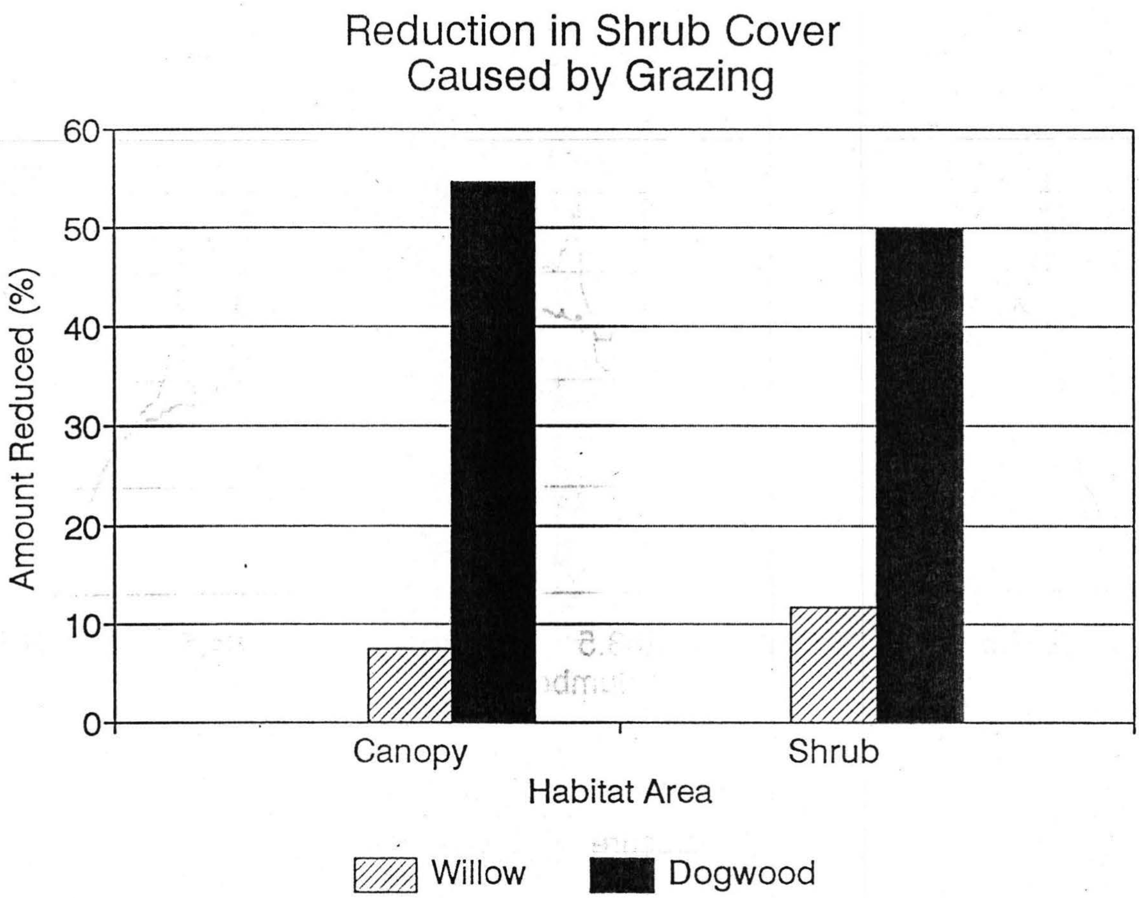


Figure 8. Effects of grazing on shrub cover.

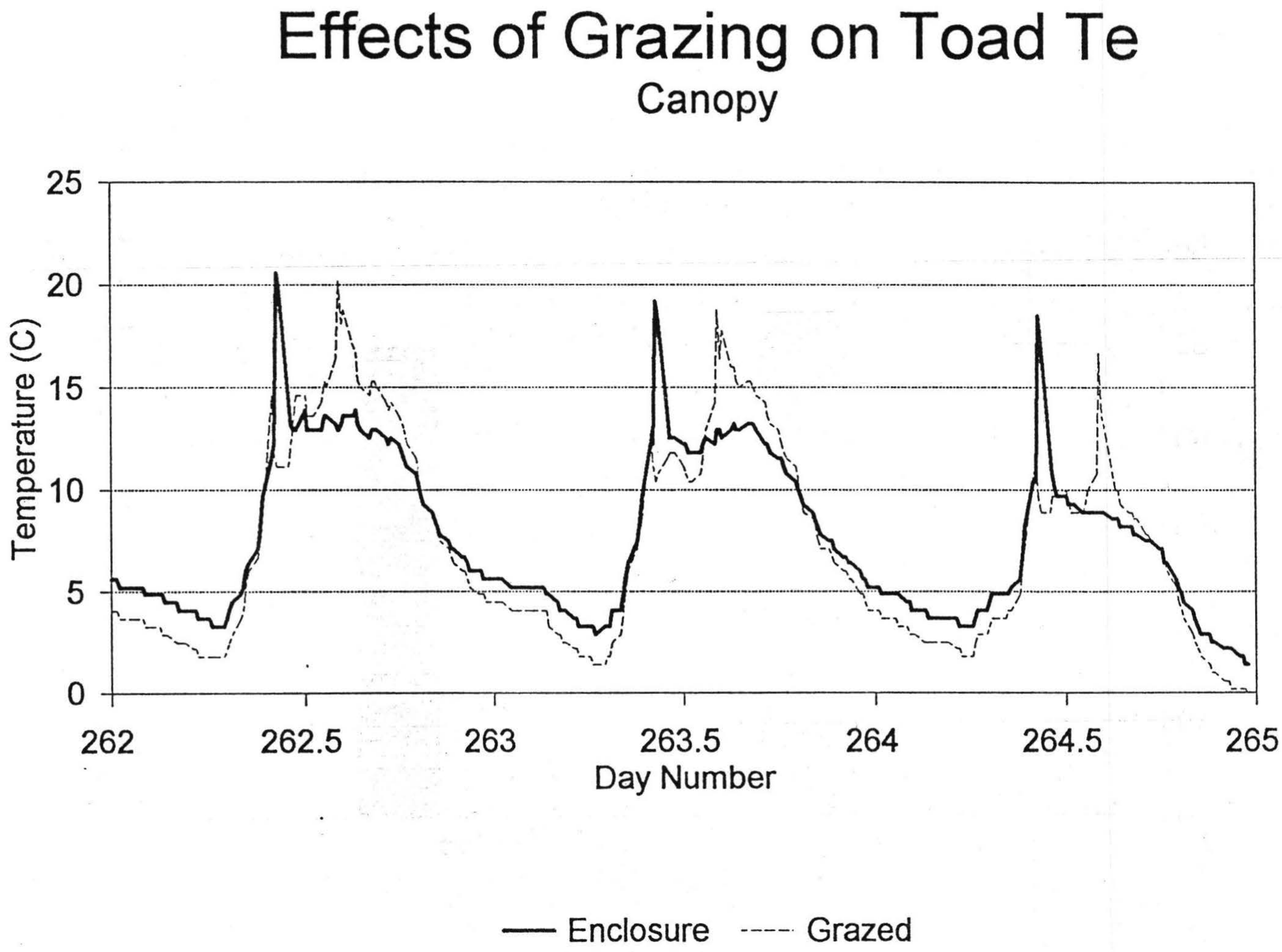


Figure 9. Effects of grazing on the operative envrionmental temperature (T_e) (September 19-21) among habitats. The daily temperature spikes were brief periods when the sun shone directly on the models through holes in the canopy. The daily variation of T_e in the grazed area appears to be slightly higher.

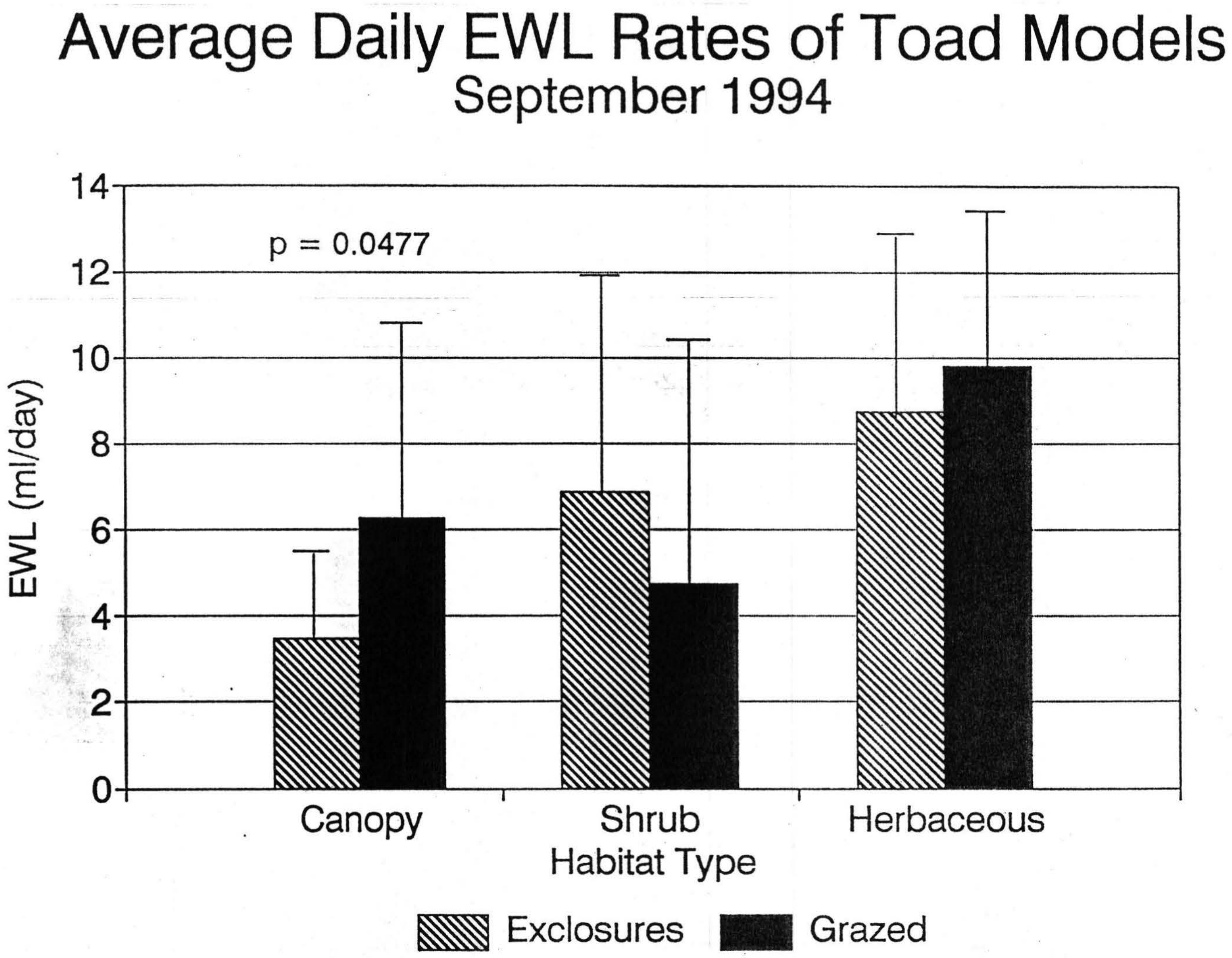


Figure 10. Effects of grazing on the daily rates of evaporative water loss (EWL) among habitats for the entire grazing period. The EWL of grazed habitats under the canopy was almost twice that of ungrazed habitats. This difference was significant. Even though the difference in EWL between the two shrub models is not significant, we attribute the slightly greater EWL of the model in the exclosure to normal variation within shrub habitat.

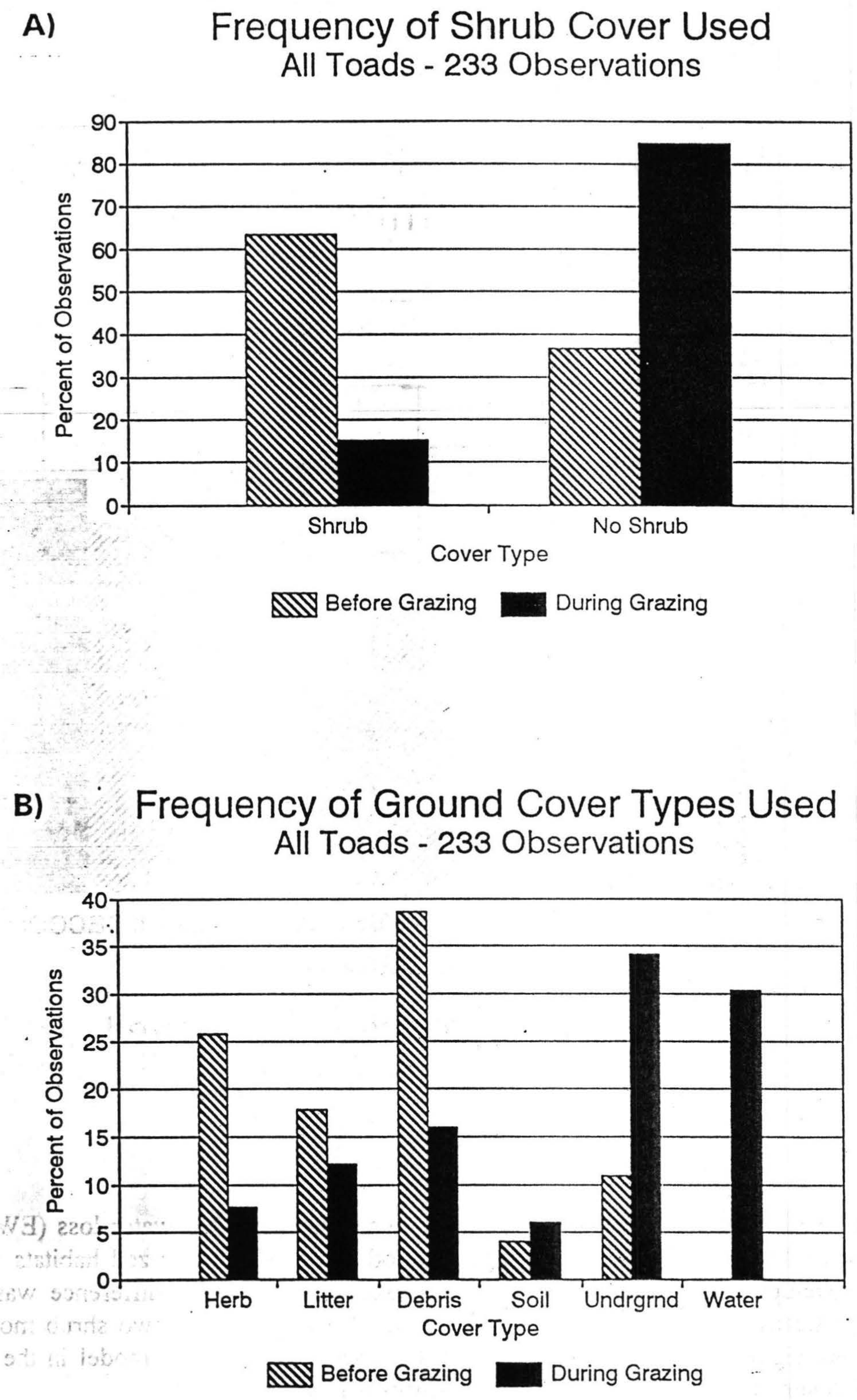


Figure 11. Frequency of shrub cover (*A*) and ground cover types (*B*) used by toads from June through the grazing period. Beginning in early August toads used sites away from shrub cover, but in or near water.